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MAGNETIC SHORING DEVICE

TECHNICAL FIELD

This invention relates to shoring apparatuses or devices for trenches, pits or other types of open excavations employed in construction industry.

BACKGROUND OF THE INVENTION

This invention relates to shoring devices for open excavations such as trenches and pits. The device includes vertical rail posts spaced apart from each other along the trench and arranged symmetrically on both sides of the trench. Opposite rail posts are kept vertically equidistant on either side of the trench by an articulated truss able to adjust the trench width. The rail post has on both sides a channel of stepped cross section. Each step constitutes a vertical guide to slide at least one shoring panel. The shoring panels slide between each corresponding guide of adjacent rail posts and, according to the number of the guides, form two or more shoring walls. Thus, the panels slide past each other creating stepped shoring wall from the top to the bottom of the excavation. The outermost and innermost steps of the shoring wall are called respectively "outer" and "inner walls" and so the panels. All other panels in between are called "intermediate". The connections between rail posts and shoring panels are performed by magnetic forces engendered by magnetic flat bar incorporated in the lateral ends of the panels. For safety purposes partial locking may be used for the outer and inner panels. The intermediate panels slide completely free relative to the rail post. The articulated truss is of scissoring type composed by triangular cells only. The cross members of the truss are pinned at their

midlength allowing rotation relative to each other such rotation allows adjustment of the truss width to several trench widths. The extremities of the cross members are pinned into vertical members of the truss which slide "formlockingly" along the rail post. For very deep applications, the vertical members of the truss have lateral guides for sliding additional panels at the bottom of excavation.

It is known to provide shoring devices having vertical rail posts, shoring panels and horizontal spreaders pressing the shoring walls against side wall of the trench. Such shoring devices are called as 'Slide Rail Shoring Systems'.

Previous slide rail shoring systems as disclosed in US Pat. Nos. 3,910,053 and 4,657,442 (Krings), use a rail post having individual formlocking channel connections of 'C' type for sliding the panels. The load developed by the active pressure of the excavation walls is spread on very limited areas of contact between post and panel whereon the stresses are highly concentrated becoming sources of high friction and temperature during the installation and removal of the system. Thus, damages is caused to both rail post and the panel, which strongly limit the application of a such system in pipeline productions, where the installation and removal of the system are effectuated continuously.

The US Pat. Nos. 5,310,289 and 5,503,504 (Hess et al.), disclose a rail post having a unique channel for a maximum of two shoring walls, created by an outer and by an inner panel. Only the outer panel slides formlockingly within the post; the inner panel is completely free and slides inside the outer panel and the rail posts. The design of inner panel presents a risk of kicking in the trench when adjacent rail posts are not plumb. This is an important safety concern for the worker inside the trench. This phenomenon becomes prominent when the depth of excavation is over 20' deep. On the other hand, shoring of excavations over 16' deep requires the stacking and connection of two or more panels, which later must be removed at once. Removing two or more panels at once is a very difficult task and sometimes even impossible to accomplish even when heavy duty equipment is used. Yet another concern faced by this design is the difficulty of removing the inner panel when the deflection of the upper panel has begun. Also, it should be noted

that a slide rail shoring system using differing types of panels a requires much bigger inventory of panels than its counterparts that use interchangeable panels.

The US Pat. Nos. 3,950,952 (Krings), 5,310,289 and 5,503,504 (Hess et al) disclose very similar strut frames having a rectangular structure where the vertical members are equipped with rollers. These frames are designed to slide vertically between opposite rail posts in order to support the load coming from either side of the shoring walls. From an engineering standpoint, a frame having a rectangular cell is not a stable structure because it will deform without affecting the length of its members. Additionally, the lower horizontal strut of the frame diminishes the pipe culvert thereby requiring special solutions for the installation of pipes having big diameters or of big box culverts.

BRIEF SUMMARY OF THE INVENTION

Substantially, the intent of present invention is to provide a shoring device of the type described above that reduce the friction and the stresses in the contacts between components, while increases the safety and eases its use in great depths. Pursuing this object and others that will become explicit hereafter, one aspect of the present invention resides on the design of the rail post. The rail post has channels of stepped cross section that permit the presence of more than two shoring walls in that single channel without increasing the material expenditure and eliminate the interference between panels as well. Since the vertical guide of the rail post is of stepped cross section, it excludes the contact between rail post and back panel, while the contact area in the front panel is increased. Another new aspect of the invention is the incorporation of magnetic flat bars in the lateral ends of the panels thereby simplifying the connections between rail post and panels and reducing the risk of damage.

The first object of this invention is to present a slide rail system having partially or completely open sliding connections for the panels along the rail post. Also, it is an object of this invention to provide a rail post in which two or more panels may slide past each other, without need for stacking. This tremendously extends the shoring depth for a

slide rail shoring system. Another object of this invention is to present an articulated truss able to adjust to several trench widths, while providing a big pipe culvert. The truss is able to preform a role in addition to just supporting opposing rail posts, such sliding additional panels in its vertical members. Also, it is the object of the invention to introduce accessory devices to be used in conjunction with the slide rail shoring system to increase safety and to facilitate its installation and removal. It is the final object of this invention to present a slide rail shoring system that has no practical limit to the depth of excavation.

The new features of the invention are set forth in the appended claims. Other advantages of the invention will be appreciated upon review of the following description and drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a sectional view of a trench showing two rail posts and an articulated truss in between.

FIG. 2 is a sectional view taken along the line I-I of the FIG. 1, showing a cross section of the rail post, shoring panels laterally on either side, and the top view of the vertical member of the articulated truss.

FIG. 3 is a schematic, top, fragmentary, sectional view of a linear rail post depicting another connection with the articulated truss.

FIG. 4 is a schematic, top, fragmentary, sectional view of a linear rail post as shown in FIG. 1, but with three guides for the panels.

FIG. 5 shows a schematic, top, fragmentary, sectional view of a corner rail post, having guide channels oriented perpendicularly to each other for creating perpendicular shoring walls.

FIG. 6 is a schematic, top, fragmentary, sectional view of a linear rail post as shown in FIG. 1, but depicting guide channels which are completely open for sliding the panels.

FIG. 7 shows a side view of the articulated truss similar to that shown in the FIG 1.

FIG. 8 is a sectional view taken along the line 2-2 of Figure 7, showing the pin connections between cross and vertical members of the truss.

FIG. 9 shows a side view of the articulated truss having a horizontal strut connecting the upper part of the vertical members.

FIG 10 shows a side view of an articulated truss wherein the vertical members have, on either side, guide channels for sliding additional panels.

FIG. 11 shows a three dimensional view of a shoring panel depicting its main features.

FIG. 12 is a partial three-dimensional view showing the connection of the cutting edge at the bottom of the panel.

FIG. 13 is a three-dimensional view of the lateral end of a panel incorporating magnetic flat bars.

FIG. 14 shows a three-dimensional view of a sliding device fixed on the back of the rail post to slide formlockingly relative to another post.

FIG. 15 shows a frame acting simultaneously on the upper and lower pairs of the rail posts.

FIG. 16 is a three dimensional view of a hammering device to be affixed to the top of a panel for preventing its damage during installation in the ground.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings where like numerals indicate like elements, various embodiments incorporating the new features of the present invention are illustrated. The shoring device has two or more pairs of rail posts spaced from each other along the excavation. FIG. 1 illustrates a pair of linear rail posts **1A** and **1B**, located symmetrically on either side of the trench. Each rail post has laterally on either side at least two guides **2** and **3** for sliding large shoring panels between adjacent rail posts. The opposite rail posts **1A** and **1B** are kept vertically equidistant by an articulated truss **16**, which is composed of cross members **18A** and **18B**, pinned together at their midlength with the

axle pin **19,** and by the vertical members **17A** and **17B**. As shown in FIG. 2, the panel guides **2A** and **3A** are inside a unique channel of stepped cross section shaped by the pieces **8**, **9A**, **10A**, and the angle **11A**. The round bars **14A** and **15A** partially lock the shoring panels **5A** and **6A,** and round bars at **back?** 15B partially lock shoring panels 5B and 6B, which shape thereby respectively an outer and an inner shoring wall. The front side of the rail post 1, as viewed looking into the excavation, has a 'C' channel shaped by the pieces **9A, 9B, 10A**, **10B** and **13**, wherein one vertical member of the articulated truss slides and is horizontally locked by the T shaped piece **20**. The load originating from the excavation wall is transmitted from the panels to the articulated truss through the rail post and the rollers **21A** and **21B** which are supported by the axles **22**, axle holder **23**, and located at the extremities of the vertical member **17** of the truss. As shown in the FIG. 3, the channel for sliding connection between the articulated truss and the rail post could be exterior to the rail post and made by two angle pieces **26A** and **26B**. As shown in the FIG. 4, the rail post could have laterally intermediate panel guides **4A** and **4B** shaped respectively by the angle pieces **12A** and **12B**. Therefore, an intermediate shoring wall may be formed by the shoring panels **7A** and **7B**.

FIG. 5 shows a top fragmentary sectional view of a rail post, a corner rail post," for pit applications. Steps **11A** and **11B** are situated within perpendicular planes and allow panels **5A** and **5B** to slid and shape adjacent outer shoring walls. Likewise, the steps made by the pieces **9A** and **9B** hold the panels **6A** and **6B** of the inner shoring walls.

In a corner rail post, round bar **15** (**A** or **B**) is optional because the inner panels **6A** and **6B** block each other due to the load coming from perpendicular directions and the fact that the inner panel are installed after the outer one.

As shown in FIG. 6, channels **2A**, **3A** and **2B**, **3B** are used for guiding respectively panels **5A, 6A** and **5B, 6B** in the linear rail post, and may be completely open when using magnetic connections. The panels have the same length and mirror each other relative to piece **13**.

As shown in FIG. 7, the articulated truss **16** has only triangular cells. The cross members **18A** and **18B** are connected to the vertical members **17A** and **17B** via the

extension **33**, flanges **34** and pin connector **30**. The pin connector 30 is fixed in one of holes **31** by pin **32**. For the same length of extensions **33,** the width of the truss (and there for the width of), could be easily modified by moving the pin connector from one hole **31** to another one. The articulated truss is manipulated by lifting holes **36** of edges **35**. As shown in FIG. 8, a nut **37** secures pin **32** of the connector **30**. FIG. 9 shows a horizontal strut **38** used within articulated truss **16**. The strut **38** is connected to the vertical members of the truss via contact flanges **40** and pin **39**. Yet another type of articulated truss **16** is shown in FIG. 10, where vertical members **17A** and **17B** are extended way below the rollers **21A** and **21B** (collectively 21 in Figs. 7 and 9) creating guides **4A** and **4B** for sliding additional panels in very deep excavations.

As shown in FIG. 11, the shoring panel has guides **41** and **42** that slide inside the rail post, lifting plates **47** provided with a hole **48**, and a cutting edge **43** fixed at bottom by the pin or bolt **50**. To prevent damage to the panel, the upper part of it is composed by two square tubes **46A** and **46 B** slightly separated from each other and having a cover plate **45**. The bottom and the top of the panel are identical and the panel may be used in either position. A thin flat plate **44**, a skin, has be used between lifting plates **47**, in the middle part of the panel only, to reinforce and reduce the bending of the panel due to the **physical?** moment that increases parabolically from zero at its ends to a maximum at the middle. Additionally, such a skin protects the panel exactly in the area where the bucket of the excavator is the most active.

The cutting edge **43** shown in FIG. 12, is pinned or bolted to the panel through holes 48A and 48B by the pins **50A** and **50B** via the plates **51A** and **51B** provided with holes respectively **52A** and **52B**.

FIG. 13 illustrates another shoring panel **5** having a magnetic connection with linear and/or corner rail post by incorporating magnetic flat bars **54** on the sides of the panel guide **41**. To prevent the damages on the magnetic flat bars, two plates **53** are fixed on the guide **41** to support the pressure of contact between post and panel.

As shown in the FIG. 14, a sliding device **55** may be fixed by bolts **57A** and **57B** on the back side of a rail post **1**. This is desirable when the depth of excavation is great and

there is a need to slide a pair of rail posts together. The sliding device **55** has a formlocking T shaped piece **53** that goes inside the 'C' channel in front of the other rail post identical to the 'T' shaped piece **20** of the articulated frame in the FIG. 1. As shown in the FIG. 15, the truss supporting the twin pairs of rail posts acts simultaneously on the upper pair of rail posts, **1A** and **1B**, through the rollers **21A**, **21B** and on the lower pair of rail posts, **1C** and **1D**, via the rollers **21C**, **21D**. The truss could be of articulated type as indicated schematically by the dash-dot line or as a rectangular frame. FIG. 16 shows another accessory device to be fixed on the top of the panel **5** to prevent damages during the installation of the system. The accessory device is made by welding together the two plates **57** and 58 and can be pinned or bolted by the pin **60** passing through the hole **48** (passing through plate 49)and **59**.

ABSTRACT

This apparatus relates to shoring of deep excavations such as pits or trenches. It includes vertical rail posts arranged symmetrically in pairs which are spaced form each other along the excavation, articulated trusses holding opposite rail posts against each other and large shoring panels sliding between adjacent rail posts on either side of the excavation. Each rail post has on either side one channel of stepped cross section guiding vertically two or more shoring panels. The connections between the post and the panel are partially or completely open. The open connections are performed by magnetic forces engendered by thin magnetic flat bars incorporated in the posts or the panels in the area of their contact. The articulated truss is of scissoring type composed of triangular cells only and their members have pinned connections. The cross members of the truss are pinned together in their mi-length enabling their relative rotation while their extremities are pinned into the vertical members which have several row of pinning holes in order to adjust the width of the trench without need for additional spreaders. The vertical members of the truss slide formlockingly between pair of opposite posts and could be adjusted at any level form the bottom of excavation.

MAGNETIC SHORING DEVICE

TECHNICAL FIELD

This invention relates to shoring apparatuses or devices for trenches, pits or other types of open excavations employed in construction industry.

[CROSS-REFERENCE TO RELATED APPLICATIONS

US PATENT DOCUMENTS

3,530,679	9/1970	Krings	405/282
3,910,053	10/1975	Krings	405/282
3,950,952	10/1976	Krings	405/282
4,145,891	03/1979	Krings	405/283
4,274,763	10/1981	Krings	405/282
4,657,442	04/1987	Krings	405/282
5,310,289	05/1994	Hess	405/282
5,503,504	04/1996	Hess	405/282]

BACKGROUND OF THE INVENTION

This invention relates to shoring devices for open excavations such as trenches and pits. The device includes vertical rail posts spaced apart from each other along the trench and arranged symmetrically on both sides of the trench. Opposite rail posts are kept vertically equidistant on either side of the trench by an articulated truss able to adjust the

trench width. The rail post has on both sides a channel of stepped cross section. Each step constitutes a vertical guide to slide at least one shoring panel. The shoring panels slide between each corresponding guide of adjacent rail posts and, according to the number of the guides, form two or more shoring walls. Thus, the panels slide past each other creating stepped shoring wall from the top to the bottom of the excavation. The outermost and innermost steps of the shoring wall are called respectively "outer" and "inner walls" and so the panels. All other panels in between are called "intermediate". The connections between rail posts and shoring panels are performed by magnetic forces engendered by magnetic flat bar incorporated in the lateral ends of the panels. For safety purposes partial locking may be used for the outer and inner panels. The intermediate panels slide completely free relative to the rail post. The articulated truss is of scissoring type composed by triangular cells only. The cross members of the truss are pinned at their [mi-length] midlength allowing [their relative] rotation relative to each other such rotation allows adjustment of the truss width to [in order to adjust] several trench widths[;]. [their]The extremities of the cross members are pinned into vertical[] members of the truss which slide "formlockingly" along the rail post. For very deep applications, the vertical members of the truss have lateral guides for sliding additional panels at the bottom of excavation.

It is known to provide shoring devices having vertical rail posts, shoring panels and horizontal spreaders pressing the shoring walls against side wall of the trench. Such shoring devices are called as 'Slide Rail Shoring Systems'[, so said hereafter].

Previous slide rail shoring systems as disclosed in US Pat. Nos. 3,910,053 and 4,657,442 (Krings), use a rail post having individual [ ]formlocking channel connections of 'C' type for sliding the panels. The load developed by the active pressure of the excavation walls is spread on very limited areas of contact between post and panel whereon the stresses are highly concentrated becoming sources of high friction and temperature during the installation and removal of the system._ Thus, [rough] damages [are engendered in] is caused to both rail post and the panel, which strongly limit the application of a such system in pipeline productions, where the installation and removal

of the system are effectuated continuously.

The US Pat. Nos. 5,310,289 and 5,503,504 (Hess et al.), disclose a rail post having a unique channel for a maximum of two shoring walls, created by an outer and by an inner panel. Only the outer panel slides formlockingly within the post; the inner panel is completely free and slides inside the outer panel and the rail posts. The design of inner panel presents a risk of kicking in the trench when adjacent rail posts are not [aplomb arising an]plumb. This is an important safety concern for the worker inside the trench. This phenomenon becomes prominent when the depth of excavation is over 20' deep. On the other hand, shoring of excavations over 16' deep requires [to stack and connect together]the stacking and connection of two or more panels, which [afterward]later must be removed at once. Removing[,] two or more panels at once is a very difficult task and some[ ]times even impossible to accomplish even when heavy duty equipment[s] [are]is used. Yet another [matter relating]concern faced by this design [faces]is the difficulty of removing the inner panel when the deflection of the upper panel [is on its way]has begun. Also, it should be noted that a slide rail shoring system using [unequal]differing types of panels a requires much bigger inventory [in]of panels than its counterparts that use interchangeable [types of] panels.

The US Pat. Nos. 3,950,952 (Krings), 5,310,289 and 5,503,504 (Hess et al) disclose very similar strut frames [of]having a rectangular structure [whose]where the vertical members are equipped with rollers. These frames are designed to slide vertically between opposite rail posts in order to support the load coming from either side of the shoring walls. From an engineering standpoint, a frame [composed by]having a rectangular cell is not a stable structure because [allows the deformations]it will deform without affecting the length of its members. [On the other hand]Additionally, the lower horizontal strut of the frame diminishes the pipe culvert thereby requiring special [remedy] solutions for the installation of pipes having big diameters or of big box culverts.

BRIEF SUMMARY OF THE INVENTION

Substantially, the intent of present invention is to provide a shoring device of the type described above that reduce the friction and the stresses in the contacts between components, while increases the safety and eases its use in great depths. Pursuing this object and others that will become explicit hereafter, one aspect of the present invention resides on the design of the rail post[,]. [which]The rail post has channels of stepped cross section [allowing to create]that permit the presence of more than two shoring walls in [a]that single channel without increasing the material expenditure and [eliminating]eliminate the interference between panels as well. Since the vertical guide of the rail post is of stepped cross section, it excludes the contact between rail post and back panel, while the contact area in the front panel is increased. Another new aspect of the invention is the incorporation of magnetic flat bars in the lateral ends of the panels thereby simplifying the connections between rail post and panels and reducing [therefore] the risk [for their]of damage.

The first object of this invention is to present a slide rail system having partially or completely open sliding connections for the panels along the rail post. Also, it is an object of this invention to provide a rail post [enabling the slide of]in which two or more panels may slide past each other, without need [of their]for stacking[,]. This tremendously [extending]extends the shoring depth for a slide rail shoring system. Another object of this invention is to present an articulated truss able to adjust to several trench widths, while providing a big pipe culvert. [and performing additional]The truss is able to preform a role in addition to [than] just supporting [opposite]opposing rail posts, such [that] sliding additional panels in its vertical members. Also, it is the object of the invention to introduce accessory devices to be used in conjunction with the slide rail shoring system [in order] to increase [the] safety and to facilitate its installation and removal. It is the final object of this invention to present a slide rail shoring system that [practically] has [not as]no practical limit to the depth of excavation.

The new features [considered as characteristic for]of the invention are set forth in the appended claims. Other advantages of the invention will be appreciated [in view]upon review of the following description and drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a sectional view of a trench showing two rail posts and an articulated truss in between.

FIG. 2 is a sectional view taken along the line I-I of the FIG. 1, showing [the]a cross section of the rail post[, said linear rail post, having laterally the], shoring panels laterally on either side, and the top view of the vertical member of the articulated truss.

FIG. 3 is a schematic, top, fragmentary, sectional view of a linear rail post depicting another connection with the articulated truss.

FIG. 4 is a schematic, top, fragmentary, sectional view of a linear rail post [according to the invention]as shown in in FIG. 1, but with three guides for the panels.

FIG. [6]5 shows a schematic, top, fragmentary, sectional view of a [rail post, said] corner rail post, [that has]having guide channels oriented perpendicularly to each other for creating perpendicular shoring walls.

FIG. [5]6 is a schematic, top, fragmentary, sectional view of a linear rail post [according to the invention]as shown in FIG. 1, but depicting guide channels which are completely open for sliding the panels.

FIG. 7 shows a side view of the articulated truss similar to [the one]that shown in the FIG 1.

FIG. 8 is a sectional view taken along the line 2-2 of [the figure]Figure 7, showing the pin [ ]connections between cross and vertical members of the truss.

FIG. 9 shows a side view of the articulated truss having a horizontal strut connecting the upper part of the vertical members.

FIG 10 shows a side view of an articulated truss wherein the vertical members have, on either side, guide channels for sliding additional panels.

FIG. 11 shows a three dimensional view of a shoring panel depicting its main features.[.]

FIG. 12 is a partial three-dimensional view showing the connection of the cutting

edge at the bottom of the panel.

FIG. 13 is a three-dimensional view of the lateral end of a panel incorporating magnetic flat bars.

FIG. 14 shows a three-dimensional view of a sliding device fixed on the back of the rail post to slide formlockingly relative to another post.

FIG. 15 shows a frame acting simultaneously on the upper and lower pairs of the rail posts.

FIG. 16 is a three dimensional view of a hammering device to be [fixed on]affixed to the top of a panel for preventing its damage during installation in the ground.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings where like numerals indicate like elements, various embodiments [ ]incorporating the new features of the present invention are illustrated. The shoring device has two or more pairs of rail posts spaced from each other along the excavation. FIG. 1[,] illustrates a pair of linear rail posts **1A** and **1B**, [said linear rail posts, which are] located symmetrically on either side of the trench. Each rail post has laterally on either side at least two guides **2** and **3** for sliding large shoring panels between adjacent rail posts. The opposite rail posts **1A** and **1B** are kept vertically equidistant by an articulated truss **16**, which is composed [by the]of cross members **18A** and **18B**, pinned together at their [mi-length]midlength with the axle pin **19,** and by the vertical members **17A** and **17B**. As shown in FIG. 2, the panel guides **2A** and **3A** are inside a unique channel of stepped cross section shaped by the pieces **8**, **9A**, **10A**, and the angle **11A**. The round bars **14A** and **15A** partially lock [partially] the shoring panels **5A** and **6A,** and round bars at back 15B partially lock shoring panels 5B and 6B, which shape thereby respectively an outer and an inner shoring wall. The front side of the rail post 1, as viewed looking [inside]into the excavation, has a 'C' channel shaped by the pieces **9A, 9B, 10A, 10B** and **13**, wherein [slides] one vertical member of the articulated truss slides and is [been] horizontally locked by the T shaped piece **20**. The load [originated

on]originating from the excavation wall is transmitted from the panels to the articulated truss through the rail post and the rollers **21A** and **21B** which are supported by the axles **22** [and the], axle holder[ ] **23**, and located at the extremities of the vertical member **17** of the truss. As shown in the FIG. 3, the channel for sliding connection between the articulated truss and the rail post could be [outer]exterior to the rail post and made by two angle pieces **26A** and **26B**. As shown in the FIG. 4, the rail post could have laterally intermediate panel guides **4A** and **4B** shaped respectively by the angle pieces **12A** and **12B**. Therefore, an intermediate shoring wall [is created]may be formed by the shoring panels **7A** and **7B**.

FIG. 5 shows a top fragmentary sectional view of a rail post, a corner rail post," for pit applications[,]. [said corner rail post. The] [s]Steps **11A** and **11B** are situated within perpendicular [plans for sliding the] planes and allow panels **5A** and **5B** to slid and shape [shaping] adjacent outer shoring walls. Likewise, the steps made by the pieces **9A** and **9B** hold the panels **6A** and **6B** of the inner shoring walls.

In a corner rail post, [the] round bar **15** (**A** or **B**) is optional because the inner panels **6A** and **6B** block each other due to the load coming from perpendicular directions and the fact that the inner panel are installed after the outer one.[.]

As shown in [the] FIG. 6, [the] channels **2A**, **3A** and **2B**, **3B** are used for guiding respectively [the] panels **5A, 6A** and **5B, 6B** in the linear rail post, [could]and may be completely open when using magnetic connections. The panels have the same length and mirror each other relative to [the] piece **13**.

As shown in FIG. 7, the articulated truss **16** has only triangular cells [only]. The cross members **18A** and **18B** are connected to the vertical members **17A** and **17B** via the extension **33**, flanges **34** and [the] pin connector **30**. The pin connector 30 is fixed in one of [the] holes **31** by [the] pin **32**. For the same length of extensions **33**, the width of the truss [(so of the trench)](and there for the width of), could be easily modified by [fixing]moving the pin connector from one hole **31** to another one. The articulated truss is manipulated by [the] lifting holes **36** of [the] edges **35**. As shown in [the] FIG. 8, a nut **37** secures [the] pin **32** of the connector **30**. _FIG. 9 shows a horizontal strut **38** used within

articulated truss **16**. The strut **38** is connected to the vertical members of the truss via contact flanges **40** and [the] pin **39**. _Yet another type of [the] articulated truss **16** is shown in [the] FIG. 10, where [the] vertical members **17A** and **17B** are extended way below the rollers **21A** and **21B** <u>(collectively 21 in Figs. 7 and 9)</u> creating [the] guides **4A** and **4B** for sliding additional panels in very deep excavations.

As shown in [the] FIG. 11, the shoring panel has [the] guides **41** and **42** [to]<u>that</u> slide inside the rail post, lifting plates **47** provided with a hole **48**, and a cutting edge **43** fixed at [the] bottom by the pin or bolt **50**. _To prevent damage[s] [on]<u>to</u> the panel, the upper part of it is composed by two square tubes **46A** and **46 B** slightly <u>separated</u> from each other and <u>having</u> a cover plate **45**. The bottom and the top of the panel are identical and [it can]<u>the panel may</u> be used [both ways]<u>in either position</u>. _A thin flat plate **44**, [said]<u>a</u> skin, [could]<u>has</u> be used between lifting plates **47**, [which means] in the middle part of the panel only, to reinforce and reduce the bending of the panel due to the physical moment [which]<u>that</u> increase<u>s</u> parabolically [ ]from zero at its ends to a maximum at the middle. [On the other hand]<u>Additionally</u>, [a] such <u>a</u> skin protect<u>s</u> the panel exactly in the area where the bucket of the excavator is the most active.

The cutting edge **43** shown in [the] FIG. 12, is pinned or bolted to the panel <u>through holes 48A and 48B</u> by the pins **50A** and **50B** via the plates **51A** and **51B** provided with holes respectively **52A** and **52B**.

FIG. 13 illustrates another shoring panel **5** [which performs]<u>having a</u> magnetic connection with [ ]linear and/or corner rail post by incorporating magnetic flat bars **54** on the sides of the panel guide **41**. To prevent the damages on the magnetic flat bars, two plates **53** are fixed on the guide **41** to support the pressure of contact between post and panel.

As shown in the FIG. 14, a sliding device **55** [could]<u>may</u> be fixed by [the] bolts [54A]<u>57A</u> and [54B]<u>57B</u> on the back side of a rail post **1**<u>.</u> <u>This is desirable</u> when the depth of excavation is great and [the]<u>there is a</u> need to slide a pair of rail post<u>s</u> [within another one is needed]<u>together</u>. The sliding device **55** has a formlocking T shaped piece **53** that goes inside the 'C' channel in front of the other rail post identical to the 'T'

shaped piece **20** of the articulated frame in the FIG. 1. As shown in the FIG. 15, the truss supporting the twin pairs of rail posts acts simultaneously on the upper pair of rail posts, **1A** and **1B**,[ ] through the rollers **21A**, **21B** and on the lower pair of rail posts, **1C** and **1D**,[ ] via the rollers **21C**, **21D**. _The truss could be of articulated type as indicated schematically by the dash-dot line or as a rectangular frame. [The] FIG. 16 shows another accessory device to be fixed on the top of the panel **5** to prevent damages during the installation of the system. The accessory device is made by welding together the two plates **57** and 58 and can be pinned or bolted by the pin **60** [within]passing through the hole **48** (passing through plate 49)and **59**.